4B Chemicals and Allied Products (SIC 28)

EPA's *Industry Screener Questionnaire: Phase I Cooling Water Intake Structures* identified sixteen 4-digit SIC codes in the Chemical and Allied Products Industry (SIC 28) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws more than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes (facilities with these characteristics are hereafter referred to as "§316(b) facilities"). For each of the sixteen SIC codes, Table 4B-1 below provides a description of the industry sector, a list of primary products manufactured, the total number of screener respondents, and the number and percent of §316(b) facilities.

Table 4B-1: §316(b) Facilities in the Chemicals and Allied Products Industry (SIC 28)

SIC	SIC Description	Important Products Manufactured	Number of Screener Respondents		
			Total	§316(b) Facilities	
				No. †	%
Inorganic Chemicals (SIC 281)					
2812	Alkalies and Chlorine	Alkalies, caustic soda, chlorine, and soda ash	28	10	35.7%
2813	Industrial Gases	Industrial gases (including organic) for sale in compressed, liquid, and solid forms	110	4	3.6%
2816	Inorganic Pigments	Black pigments, except carbon black, white pigments, and color pigments	26	4	15.4%
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	Miscellaneous other industrial inorganic chemicals	271	17	6.3%
Total 281			***435***	***35***	***8.0%***
Plastics Material and Resins (SIC 282)					
2821	Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers	Cellulose plastics materials; phenolic and other tar acid resins; urea and melamine resins; vinyl resins; styrene resins; alkyd resins; acrylic resins; polyethylene resins; polypropylene resins; rosin modified resins; coumarone-indene and petroleum polymer resins; miscellaneous resins	***305***	***14***	***4.6%***
Organic Chemicals (SIC 286)					
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	Aromatic chemicals, such as benzene, toluene, mixed xylenes naphthalene, synthetic organic dyes, and synthetic organic pigments	59	5	8.5%
2869	Industrial Organic Chemicals, Not Elsewhere Classified	Aliphatic and other acyclic organic chemicals; solvents; polyhydric alcohols; synthetic perfume and flavoring materials; rubber processing chemicals; plasticizers; synthetic tanning agents; chemical warfare gases; and esters, amines, etc.	368	53	14.4%
Total 286			***427***	***58***	***13.6%***
Other Chemical Sectors					
2823	Cellulosic Manmade Fibers	Cellulose acetate and regenerated cellulose such as rayon by the viscose or cuprammonium process	7	2	28.6%

Table 4B-1: §316(b) Facilities in the Chemicals and Allied Products Industry (SIC 28)

SIC	SIC Description	Important Products Manufactured	Number of Screener Respondents		
			Total	§316(b) Facilities	
				No. †	%
2824	Manmade Organic Fibers, Except Cellulosic	Regenerated proteins, and polymers or copolymers of such components as vinyl chloride, vinylidene chloride, linear esters, vinyl alcohols, acrylonitrile, ethylenes, amides, and related polymeric materials	32	6	18.8%
2833	Medicinal Chemicals and Botanical Products	Agar-agar and similar products of natural origin, endocrine products, manufacturing or isolating basic vitamins, and isolating active medicinal principals such as alkaloids from botanical drugs and herbs	33	3	9.1%
2834	Pharmaceutical Preparations	Intended for final consumption, such as ampoules, tablets, capsules, vials, ointments, medicinal powders, solutions, and suspensions	91	4	4.4%
2841	Soaps and Other Detergents, Except Speciality Cleaners	Soap, synthetic organic detergents, inorganic alkaline detergents	36	4	11.1%
2873	Nitrogenous Fertilizers	Ammonia fertilizer compounds and anhydrous ammonia, nitric acid, ammonium nitrate, ammonium sulfate and nitrogen solutions, urea, and natural organic fertilizers (except compost) and mixtures	60	8	13.3%
2874	Phosphatic Fertilizers	Phosphoric acid; normal, enriched, and concentrated superphosphates; ammonium phosphates; nitro-phosphates; and calcium meta-phosphates	37	4	10.8%
2892	Explosives	Explosives excluding ammunition for small arms and fireworks	10	1	10.0%
2899	Chemicals and Chemical Preparations, Not Elsewhere Classified	Fatty acids; essential oils; gelatin (except vegetable); sizes; bluing; laundry sours; writing and stamp pad ink; industrial compounds; metal, oil, and water treating compounds; waterproofing compounds; and chemical supplies for foundries	162	5	3.1%
Total Other			***468***	***37***	***7.9%***
Total Chemicals and Allied Products (SIC 28)					
Total 28			**1,635**	**144**	**8.8%**

† Information on the percentage of intake flow used for cooling purposes was not available for all screener respondents. Facilities for which this information was not available were assumed to use at least 25% of their intake flow for cooling water purposes The reported numbers of §316(b) facilities may therefore be overstated.

†† SIC code 281 is officially titled "Industrial Inorganic Chemicals." However, to avoid confusion with SIC code 2819, "Industrial Inorganic Chemicals, Not Elsewhere Classified," this profile will refer to SIC code 281 as the "Inorganic Chemicals sector."

††† SIC code 286 is officially titled "Industrial Organic Chemicals." However, to avoid confusion with SIC code 2869, "Industrial Organic Chemicals, Not Elsewhere Classified," this profile will refer to SIC code 286 as the "Organic Chemicals sector."

Source: EPA, Industry Screener Questionnaire: Phase I Cooling Water Intake Structures, 1999; Executive Office of the President, Office of Management and Budget, Standard Industrial Classification Manual 1987.

The responses to the Screener Questionnaire indicate that three main chemical sectors account for the largest numbers of §316(b) facilities: (1) Inorganic Chemicals (including SIC codes 2812, 2813, 2816, and 2819); (2) Plastics Material and Resins (SIC code 2821); and (3) Organic Chemicals (including SIC codes 2865 and 2869). Of the 144 §316(b)

facilities in the Chemical industry, 58 facilities, or 40 percent, belong to the Organic Chemicals sector, 35, or 24 percent, belong to the Inorganic Chemicals sector, and 14, or 5 percent, belong to the Plastics and Resins sector. The remainder of the Chemicals and Allied Products profile therefore focuses on these three industry groups.

4B.1 Domestic Production

The U.S. Chemical and Allied products industry comprises a wide array of companies that, in total, produce more than 70,000 different chemical substances. These products range from commodity materials used in other industries to finished consumer products such as soaps and detergents. The industry accounts for a higher share (nearly 12 percent) of the U.S. manufacturing gross domestic product (GDP) than any other industry sector, and produces approximately two percent of total national gross domestic product (McGraw-Hill, 1998).

Inorganic and organic chemicals are the major outputs of the chemical industry. They are derived from crude oil, natural gas, and various other natural resources. Raw materials containing hydrocarbons such as oil, natural gas, and coal are primary feedstocks for the production of organic chemicals. Inorganic chemicals are chemicals that do not contain carbon but are produced from other gases and minerals (McGraw-Hill, 1998).

The Chemicals and Allied products industry is highly energy intensive. It is one of the largest industrial users of electric energy and also consumes large amounts of oil and natural gas. In total, the industry accounts for approximately seven percent of total U.S. energy consumption, including 11 percent of all natural gas use. Just over 50 percent of the industry's energy consumption is used as feedstock in the production of chemical products. The remaining energy consumption is for fuel and power for production processes. Oil accounts for approximately 42 percent of total energy consumption by the industry. For some products, e.g., petrochemicals, energy costs account for up to 85 percent of total production costs. Overall, total energy costs represent seven percent of the value of chemical industry shipments (S&P, 2000).

a. Output

Figure 4B-1 shows the trend in ***value of shipments*** and ***value added*** for the three profiled sectors between 1988 and 1996.[1] Value of shipments and value added are two of the most common measures of manufacturing output. They provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

The Organic Chemicals sector (SIC 281) experienced a significant decrease in both value of shipments and value added between 1994 and 1996. This decrease is a function of increased competition in the global market for petrochemicals which comprise the majority of organic chemical products. The increased competition stems from the considerable capacity expansions for these products seen in developing nations in recent years (McGraw-Hill, 1998).

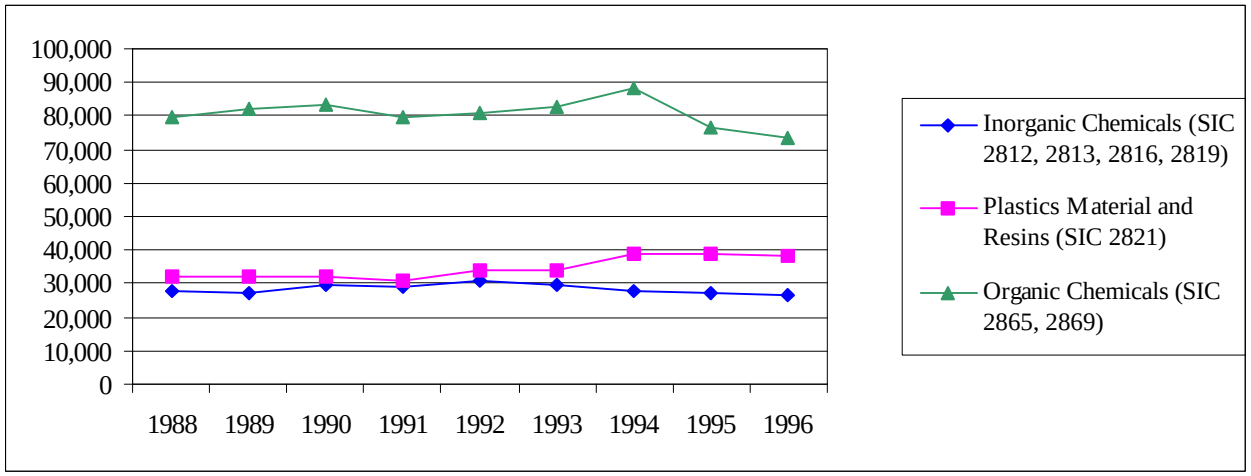
The Plastics Material and Resin (SIC 2821) and Inorganic Chemicals (SIC 286) sectors have remained relatively stable over the period between 1988 and 1996. The stability in these industry sectors reflects various trends in the markets for their products which are heavily influenced by the overall health and stability of the U.S. economy. In the early 1990s, domestic producers benefitted from the relatively weak dollar which made U.S. products more competitive in the global market. In more recent years, the strength of the U.S. economy has bolstered domestic end-use markets, offsetting the reductions in exports that have resulted from increased global competition and a strengthened dollar (McGraw-Hill, 1998).

Figure 4B-1 shows the trend in value of shipments and value added for the three profiled chemicals sectors between 1988 and 1996.

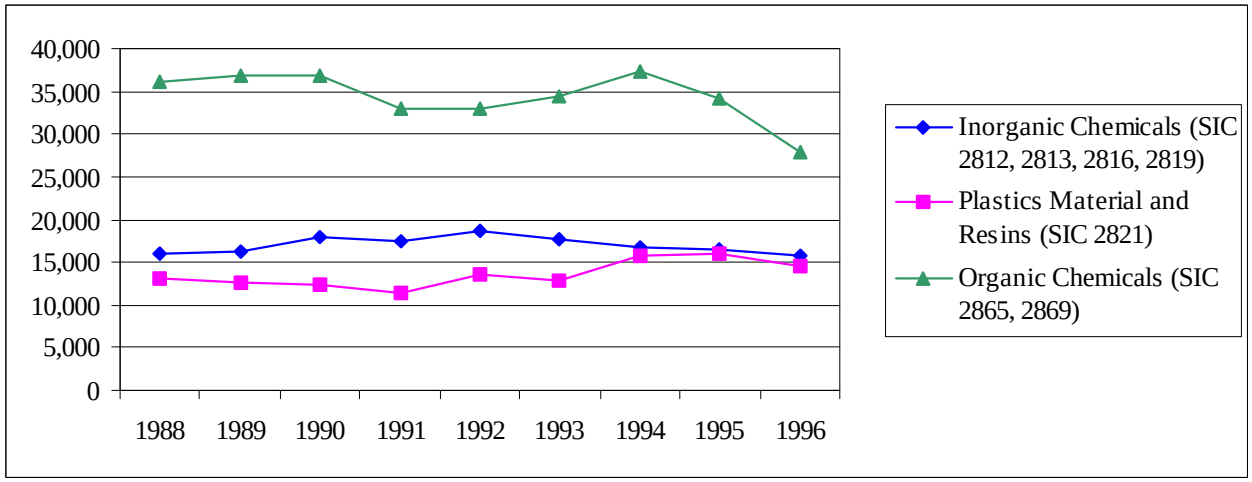
[1] Terms highlighted in bold and italic font are further explained in the glossary.

Figure 4B-1: Value of Shipments and Value Added for Profiled Chemical Sectors ($1999 million)

Value of Shipments ($1999 million)



Value Added ($1999 million)



Source: Department of Commerce, Bureau of the Census, Annual Survey of Manufactures.

b. Prices

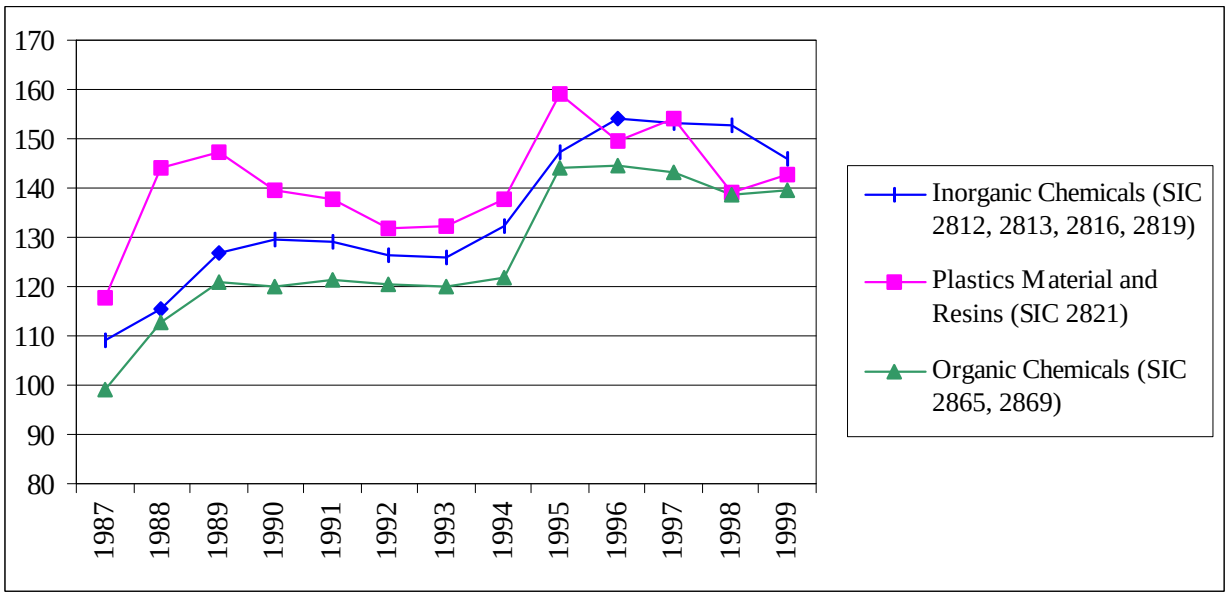
Selling prices for the products of the Organic and Inorganic Chemical sectors have increased from 1987 to 1989 and remained stable through 1994. Between 1994 and 1995, prices increased sharply, followed by a period of stable prices through 1997. Prices for plastics material and resins followed a trend similar to the other two chemical industry sectors but with larger fluctuations (see Figure 4B-2).

The fluctuations in chemical and plastics prices are in part a function of energy prices. Basic petrochemicals, which comprise the majority of organic chemical products, require energy input which can account for up to 85 percent of total production costs. The prices of natural gas and oil therefore influence the production costs and the selling price for these products. High basic petrochemical prices eventually trickle down to affect prices for chemical intermediates and final end products, including organic chemicals and plastics.

Another factor influencing prices for commodity chemical products is the cyclical nature of market supply and demand conditions. The Plastics, and Organic and Inorganic Chemical sectors are characterized by large capacity additions which can lead to fluctuations in prices in response to imbalances in supply and demand.

Figure 4B-2 shows the ***producer price index*** (PPI) at the 4-digit SIC code for the profiled chemical sectors. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to inflate nominal monetary values to constant dollars.

Figure 4B-2: Producer Price Indexes for Profiled Chemical Sectors



Source: Bureau of Labor Statistics, Producer Price Index.

c. Number of Facilities and Firms

According to the Statistics of U.S. Businesses, the number of facilities in the Organic and Inorganic Chemical sectors remained relatively stable between 1989 and 1996. Table 4B-2 shows a downward trend in the number of facilities producing inorganic chemical products following a peak in 1991. This decrease is likely the result of the recent trend towards consolidation in the inorganic chemical sector. Consolidation is a means of paring costs with companies making acquisitions and consolidating operations in an attempt to reduce costs and achieve economies of scale (S&P, 2000).

While the Organic and Inorganic Chemical sectors have remained stable, the Plastics Material and Resins sector has experienced a significant increase in the number of facilities reported between 1993 and 1996. This increase reflects the fragmentation of the plastics market with a large number of plastics and resins being produced for a number diverse markets. The Plastics sector, like the Organic and Inorganic Chemical sectors, has experienced a trend toward consolidation. However, the largest industry sectors tend to be less consolidated than the smaller specialty product sectors where a small number of producers dominate (McGraw-Hill, 1999).

Table 4B-2: Number of Facilities for Profiled Chemical Sectors

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)		Plastics Material and Resins (SIC 2821)		Organic Chemicals (SIC 2865, 2869)	
	Number of Facilities	Percent Change	Number of Facilities	Percent Change	Number of Facilities	Percent Change
1989	1,387	n/a	504	n/a	844	n/a
1990	1,421	2%	517	3%	837	-1%
1991	1,508	6%	529	2%	851	2%
1992	1,466	-3%	460	-13%	888	4%
1993	1,476	1%	502	9%	908	2%
1994	1,460	-1%	499	-1%	902	-1%
1995	1,425	-2%	558	12%	907	1%
1996	1,396	-2%	630	13%	868	-4%
Percent Change 1989-1996		1%		25%		3%

† There is significant variation in facility and firm counts that occur across data sources due to many factors including reporting and definitional differences.

Source: Small Business Administration, Statistics of U.S. Businesses.

The trend in the number of firms between 1989 and 1996 has been similar to the number of facilities. The number of firms remained relatively stable for both the Organic and Inorganic Chemical sectors. The Plastics Material and Resins sector experienced a significant increase in the number of firms reported between 1993 and 1996 increasing from 284 to 403 firms.

Table 4B-3 shows the number of firms in the three profiled chemical sectors between 1990 and 1996.

Table 4B-3: Number of Firms for Profiled Chemical Sectors

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)		Plastics Material and Resins (SIC 2821)		Organic Chemicals (SIC 2865, 2869)	
	Number of Firms	Percent Change	Number of Firms	Percent Change	Number of Firms	Percent Change
1990	640	n/a	301	n/a	579	n/a
1991	678	6%	319	6%	584	1%
1992	699	3%	255	-20%	611	5%
1993	683	-2%	284	11%	648	6%
1994	677	-1%	295	4%	644	-1%
1995	657	-3%	343	16%	644	0%
1996	625	-5%	403	17%	596	-7%
Percent Change 1990-1996		-2%		34%		3%

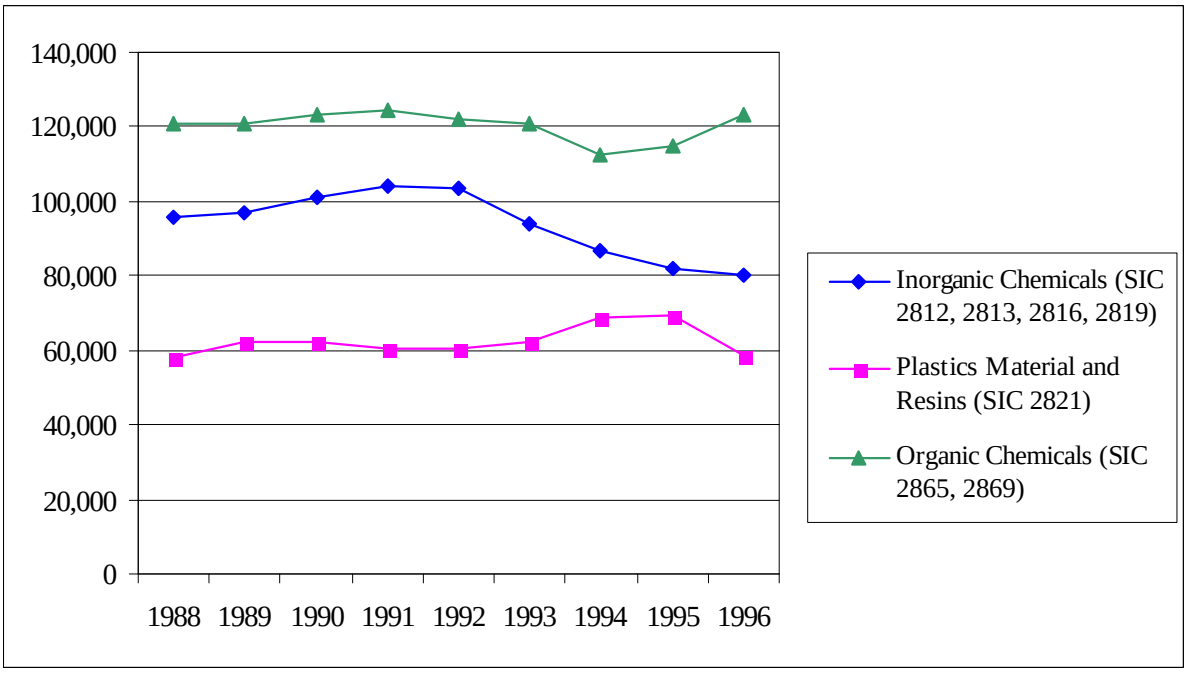
† There is significant variation in facility and firm counts that occur across data sources due to many factors including reporting and definitional differences.

Source: Small Business Administration, Statistics of U.S. Businesses.

d. Employment and Productivity

Employment is a measure of the level and trend of activity in an industry. Figure 4B-3 below provides information on employment from the Annual Survey of Manufactures. With the exception of minor short-lived fluctuations, employment in the Organic Chemical and Plastics and Resins sectors remained stable between 1992 and 1996. The Inorganic Chemicals sector, however, experienced a significant decrease in employment from 103,400 to 80,200 employees over the same time period. This decrease reflects the industry's restructuring and downsizing efforts intended to reduce costs in response to competitive challenges.

Figure 4B-3: Employment for Profiled Chemical Sectors



Source: Department of Commerce, Bureau of the Census, Annual Survey of Manufactures.

Table 4B-4 presents the change in value added per labor hour, a measure of ***labor productivity***, for each of the profiled industry sectors between 1988 and 1996. The trends in each sector, particularly Plastic Materials and Resins and Organic Chemicals, show considerable volatility throughout the early and mid 1990s. The gains in productivity in the Inorganic Chemicals sector likely reflects facilities' attempts to reduce costs by restructuring production and materials handling processes in response to maturing domestic markets and increased global competition (S&P, 2000). The decreases in the labor productivity of the Organic Chemicals sector is a function of the sharp declines in value added resulting from increased competition in the global market for petrochemicals.

Table 4B-4: Productivity Trends for Profiled Chemical Sectors, Millions of $1999

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)				Plastics Material and Resins (SIC 2821)				Organic Chemicals (SIC 2865, 2869)			
	Value Added	Prod. Hours (mill.)	Value Added/Hour		Value Added	Prod. Hours (mill.)	Value Added/Hour		Value Added	Prod. Hours (mill.)	Value Added/Hour	
			No.	% Change			No.	% Change			No.	% Change
1988	16,020	114	141	n/a	13,087	80	164	n/a	36,058	152	238	n/a
1989	16,291	109	150	6%	12,594	84	150	-8%	36,947	155	239	1%
1990	17,880	115	156	4%	12,484	83	151	1%	36,816	156	236	-1%
1991	17,366	121	144	-8%	11,403	81	141	-7%	32,863	156	211	-11%
1992	18,643	120	155	8%	13,538	79	172	22%	33,025	155	213	1%
1993	17,811	108	165	6%	12,902	81	159	-8%	34,488	156	221	4%
1994	16,703	101	166	0%	15,871	89	178	11%	37,308	146	256	16%
1995	16,561	100	165	0%	15,907	92	173	-2%	34,106	147	232	-9%
1996	15,774	97	163	-1%	14,614	81	181	5%	27,827	158	176	-24%
Percent Change 1988-1996				15%				11%				-26%

Source: Department of Commerce, Bureau of the Census, Annual Survey of Manufactures.

e. Capital Expenditures

The chemicals industry is relatively capital-intensive, with aggregate capital spending of $28.4 billion in 1998 (S&P, 2000). Capital-intensive industries are characterized by large, technologically complex manufacturing facilities which reflect the economies of scale required to manufacture products efficiently. ***New capital expenditures*** are needed to extensively modernize, expand, and replace existing capacity to meet growing demand. All three profiled chemical industry sectors have experienced substantial increases in capital expenditures over the past ten years. Table 4B-5 shows that capital expenditures in the Inorganic Chemicals, the Plastics, and the Organic Chemicals sectors have increased by 85, 75, and 41 percent, respectively, over the past ten years. Much of this growth in capital expenditures is driven by investment in capacity expansions worldwide to meet the increase in global demand for chemical products. The continued globalization of the chemical industry has expanded markets and provided U.S. producers with the opportunity to invest in foreign markets and improve their international competitiveness. Domestically, the continued substitution of synthetic materials for other basic materials and rising living standards has resulted in consistent growth in the demand for chemical commodities (S&P, 2000).

Table 4B-5: Capital Expenditures for Profiled Chemical Sectors ($1999 millions)

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)		Plastics (SIC 2821)		Organic Chemicals (SIC 2865, 2869)	
	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change
1987	1,028	n/a	1,514	n/a	n/a	n/a
1988	1,043	1%	1,592	5%	4,326	n/a
1989	1,513	45%	1,906	20%	5,149	19%
1990	1,475	-3%	2,494	31%	6,517	27%
1991	1,535	4%	2,332	-7%	6,637	2%
1992	1,742	14%	1,850	-21%	6,105	-8%
1993	1,345	-23%	2,079	12%	5,221	-14%
1994	1,449	8%	2,630	27%	4,464	-15%
1995	1,735	20%	2,099	-20%	4,960	11%
1996	1,900	9%	2,657	27%	6,107	23%
Percent Change 1987-1996		85%		75%		41%

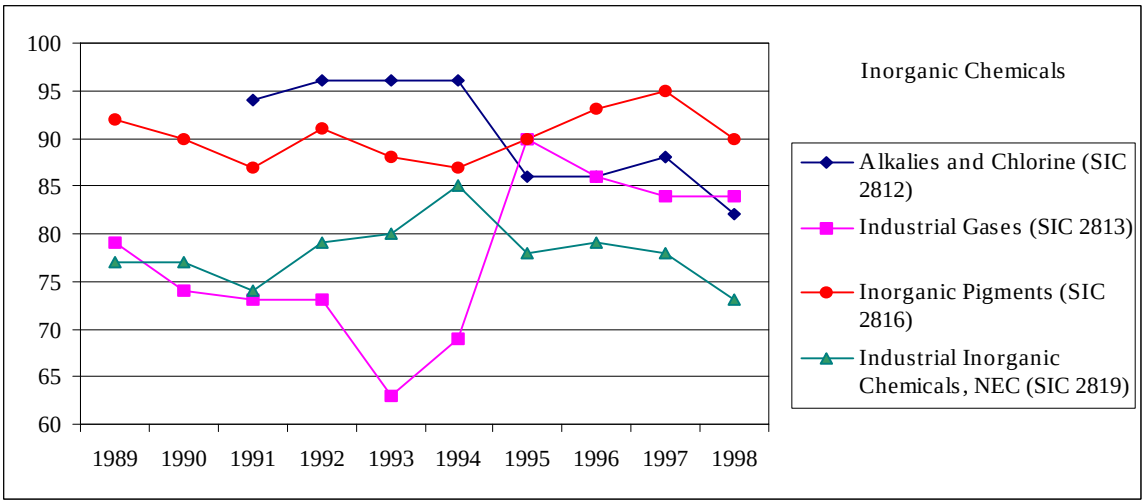
Source: Department of Commerce, Bureau of the Census, Annual Survey of Manufactures.

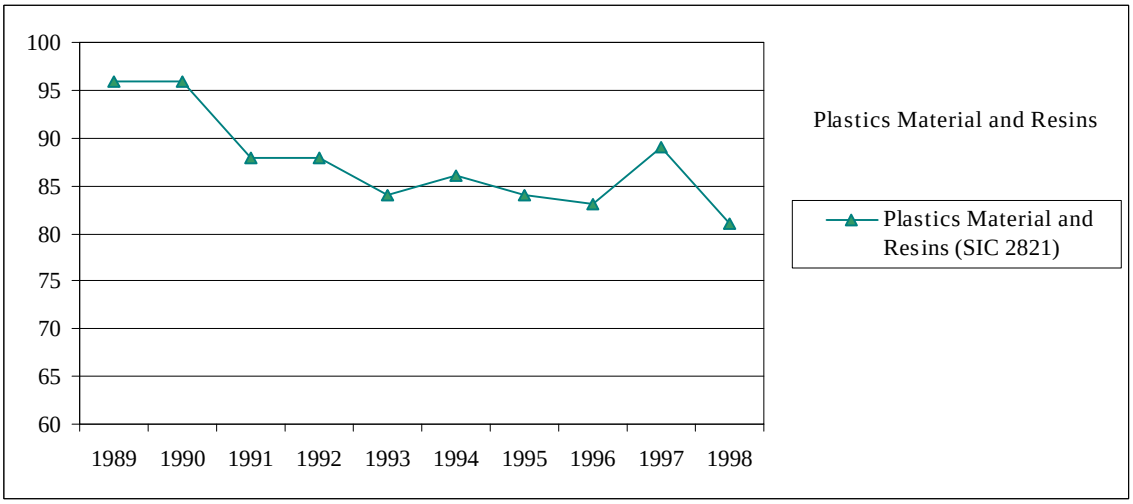
f. Capacity Utilization

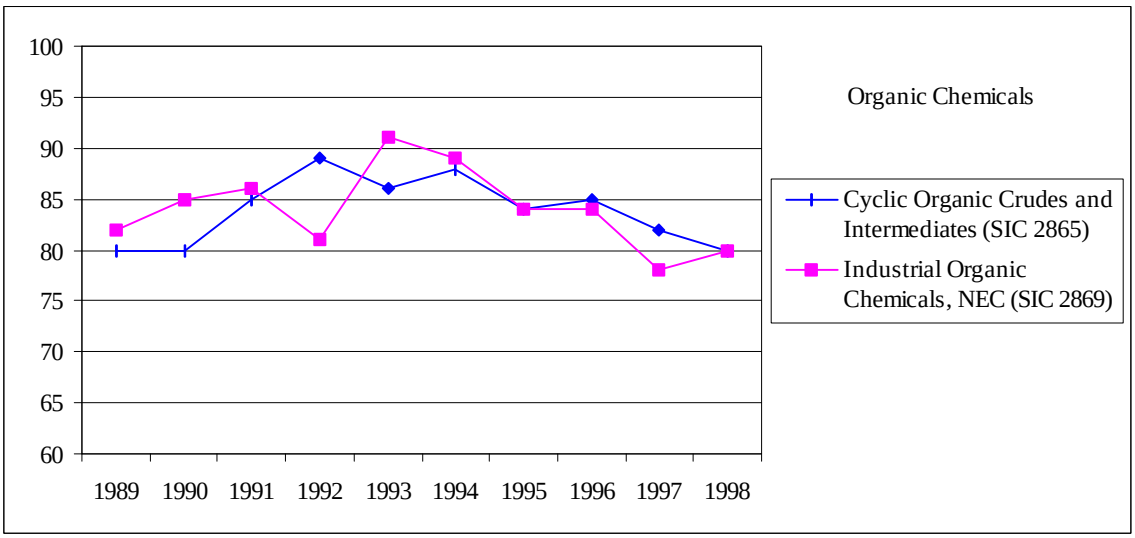
Capacity utilization measures actual output as a percentage of total potential output given the available capacity and is used as a key barometer of an industry's health. Capacity utilization is an index used to identify potential excess or insufficient capacity in an industry which can help project whether new investment is likely. To take advantage of economies of scale, chemical commodities are typically produced in large facilities. Capacity additions in this industry are often made on a relatively large scale and can substantially affect the industry's capacity utilization rates. Figure 4B-4 presents the capacity utilization index from 1989 to 1998 for specific 4-digit SIC codes within each of the profiled sectors in the chemicals industry. Capacity utilization in the Organic Chemicals sector has remained stable throughout the 1990s with only moderate fluctuations between 1989 and 1998. The Plastics and Resins sector has experienced a consistent downward trend as a result of the considerable consolidation of the industry in the last decade.

Overall, the Inorganic Chemicals sector has demonstrated the most volatility in capacity utilization between 1989 and 1998. The chlor-alkali industry (SIC code 2812) has experienced an almost consistent decline in the capacity utilization index since its high of 96 percent from 1992 through 1994. This decrease reflects the enactment of treaties and legislation designed to reduce the emission of chlorinated compounds into the environment. These regulations decreased the demand for chlorine which, together with caustic soda, accounts for more than 75 percent of production by this sector. As demand for chlorine declined, prices weakened and capacity utilization contracted. The significant increase in capacity utilization in the industrial gases sector (SIC code 2813) in the mid 1990s reflects the expansion of key end-use markets such as the chemicals, primary metals, and electronics industries. In contrast, capacity utilization in the pigments and other inorganic chemicals sectors (SIC codes 2816 and 2819) remained relatively stable between 1989 and 1998. The stability in these sectors reflects the fact that these are essentially mature markets where the demand for products tend to track growth in gross domestic product (GDP) (McGraw-Hill 1999).

Figure 4B-4: Capacity Utilization Indexes for Profiled Chemical Sectors







Source: Department of Commerce, Bureau of the Census, Current Industrial Reports, Survey of Plant Capacity.

4B.2 Structure and Competitiveness of the Chemical and Allied Products Industry

The chemicals industry continues to restructure and reduce costs in response to competitive challenges, including global oversupply for commodities. In the early 1990s, the chemical industry's cost-cutting came largely from restructuring and downsizing. The industry recently has moved toward trying to improve productivity. The industry's trend towards consolidation is another means of cutting costs. In general, companies seeking growth within maturing industry sectors are making acquisitions to achieve production or marketing efficiencies. The Plastics Material and Resins sector (SIC code 282), for example, has recently experienced sizable consolidations (S&P, 2000).

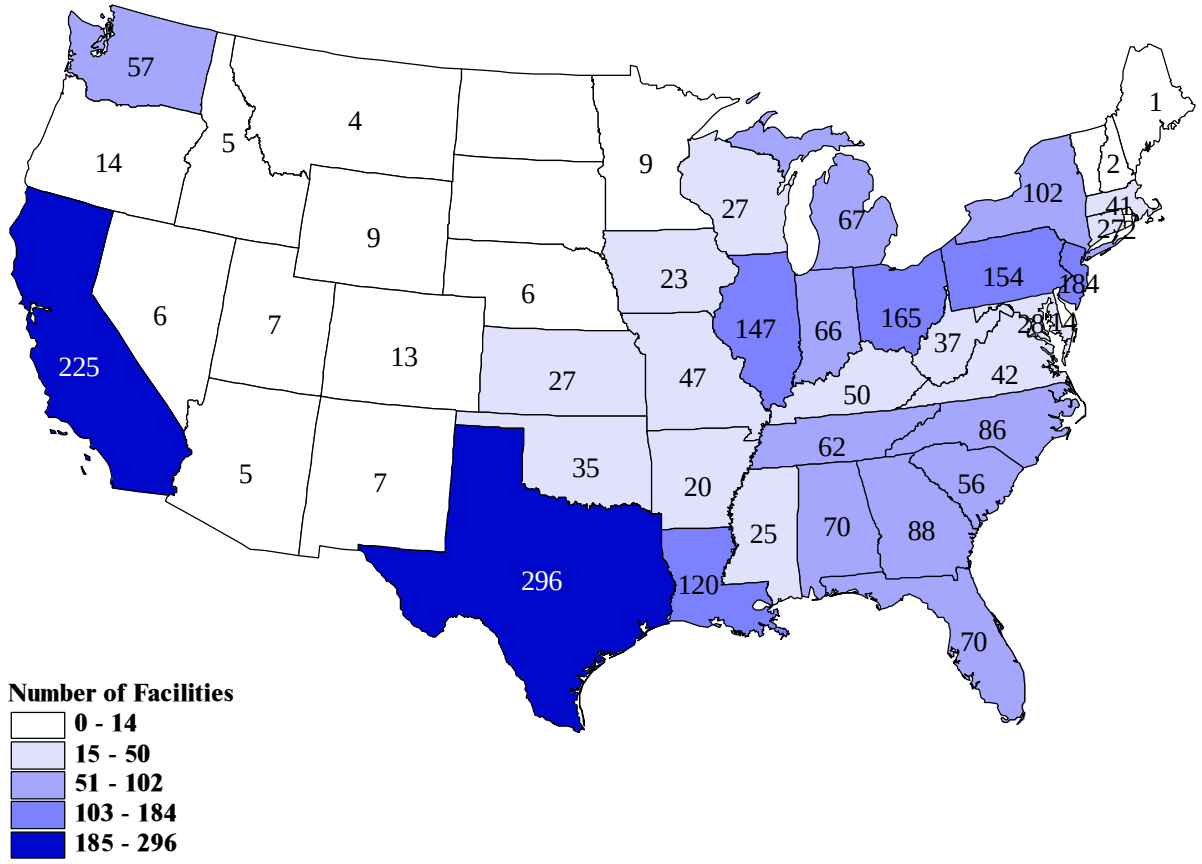
a. Geographic Distribution

Chemical manufacturing facilities are located in every state but almost two-thirds of U.S. chemical production is concentrated in ten states. Given the low value of many commodity chemicals and the handling problems posed by products such as industrial gases, nearly two-thirds of the tonnage shipped was transported less than 250 miles in 1998 (S&P, 2000).

The Industrial Organic Chemical sector is geographically diverse. Cyclic crudes and intermediates (SIC 2865) and unclassified industrial organic chemicals (SIC 2869) are concentrated in Texas, New Jersey, Ohio, California, New York, and Illinois. Facility sites are typically chosen for their access to raw materials such as petroleum and coal products and to transportation routes. In addition, since much of the market for organic chemicals is the chemical industry, facilities tend to cluster near such end-users (U.S. EPA, 1995a).

Inorganic Chemical facilities (SIC 281) are typically located near consumers and, to a lesser extent, raw materials. The largest use of inorganic chemicals is in industrial processes for the manufacture of chemicals and nonchemical products. Facilities are therefore concentrated in the heavy industrial regions along the Gulf Coast, both East and West coasts, and the Great Lakes region. Since a large portion of the inorganic chemicals produced are used by the Organic Chemicals manufacturing industry, the geographical distribution of inorganic facilities is very similar to that of organic chemicals facilities (US EPA, 1995b). Facilities in the Plastics Material and Resins sector (SIC 2821) are concentrated in the heavy industrial regions, similar to both the organic and inorganic chemicals facilities.

Figure 4B-5: Number of Chemical Facilities by State for Profiled Chemical Sectors



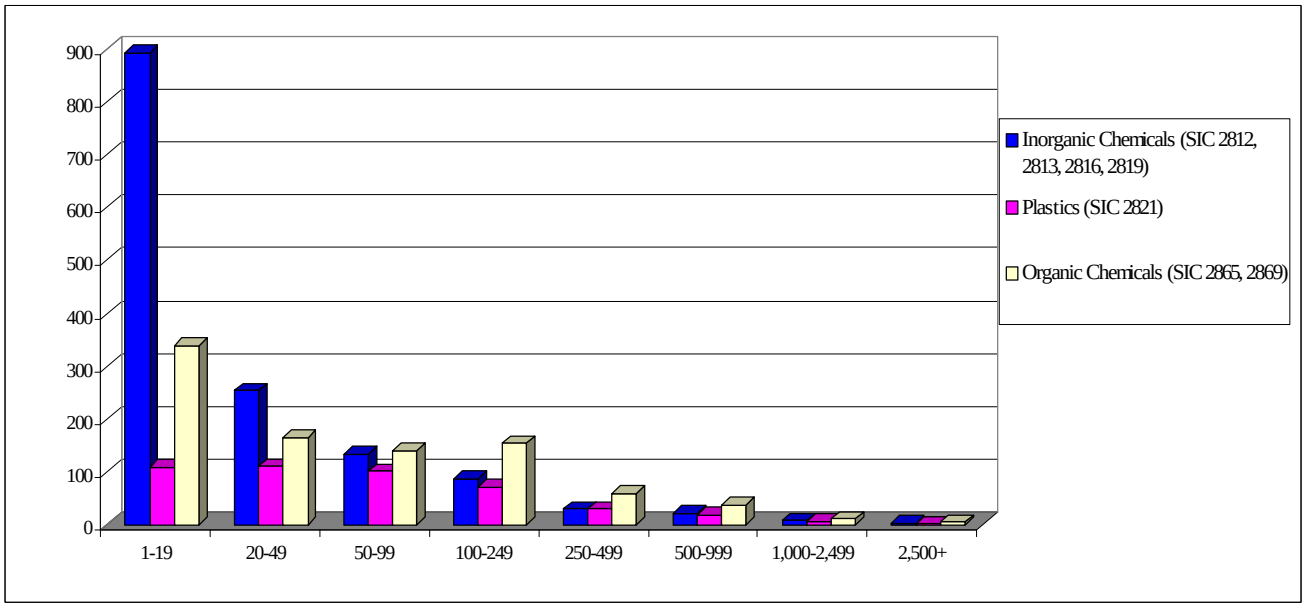
Source: Department of Commerce, Bureau of the Census, Census of Manufactures, 1992.

b. Facility Size

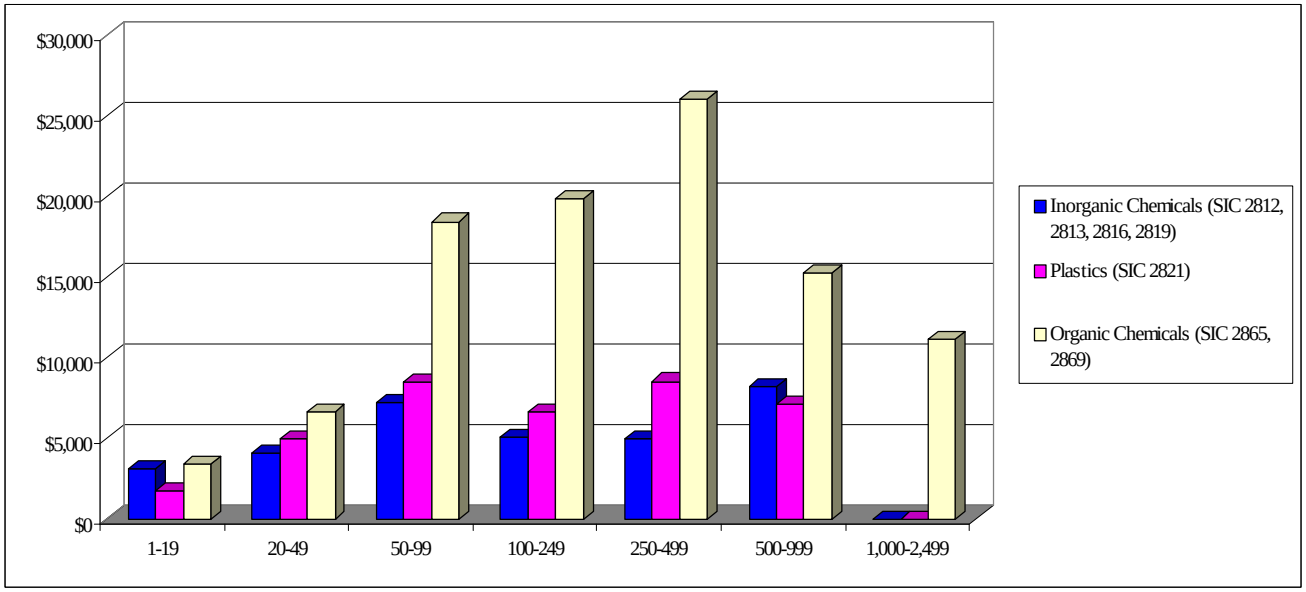
The three profiled chemicals industry sectors are characterized by a large number of small facilities, with more than 67 percent of facilities employing fewer than 50 employees and only eight percent employing 250 or more employees. However, the larger facilities in the three sectors account for the majority of the industries' output. This fact is most pronounced in the Inorganic Chemicals sector where facilities with fewer than 20 employees account for 63 percent of all facilities but for only 8 percent of the industry's value of shipments. In the Organic Chemicals sector, approximately 29 percent of all facilities employ 100 employees or more. These facilities account for about 87 percent of the value of shipments for the industry. Similarly, facilities in the Plastics Industry with more than 100 employees account for only 29 percent of all facilities but for 80 percent of the industry's value of shipments (see Figure 4B-6 below).

Figure 4B-6: Number of Facilities and Value Added by Employment Size Category for Profiled Chemical Sectors

Number of Facilities (1992)



1992 Value of Shipments (millions $1999)



Source: Department of Commerce, Bureau of the Census, Census of Manufactures, 1992.

c. Firm Size

The Small Business Administration (SBA) defines small firms in the chemical industries according to the firm's number of employees. Firms in the Inorganic Chemicals sector (SIC codes 2812, 2813, 2816, 2819) and in Industrial Organic Chemicals, NEC (SIC code 2869) are defined as small if they have 1,000 or fewer employees; firms in Plastics Material and Resins (SIC 2821) and Cyclic Organic Crudes and Intermediates (SIC code 2865) are defined as small if they have 750 or fewer employees.

The size categories reported in the Statistics of U.S. Businesses (SUSB) do not coincide with the SBA small firm standards of 750 and 1,000 employees. It is therefore not possible to apply the SBA size thresholds precisely. The SUSB data presented in Table 4B-6 show that in 1996, 483 of 625 firms in the Inorganic Chemicals sector had less than 500 employees. Therefore, at least 77 percent of firms in this sector were classified as small. These small firms owned 545 facilities, or 39 percent of all facilities in the sector. In the Plastics and Resins Industry sector, 309 of 403 firms, or 77 percent, had less than 500 employees in 1996. These small firms owned 328 of 630 facilities (52 percent) in the sector. In the Organic Chemicals Industry sector, 71 percent of facilities (423 of 596) had fewer than 500 employees, owning 53 percent of all facilities in that sector.

Table 4B-6 below shows the distribution of firms, facilities, and receipts in the Inorganic Chemicals, Plastics Material and Resins, and Organic Chemicals sectors by the employment size of the parent firm.

Table 4B-6: Number of Firms, Facilities and Estimated Receipts by Firm Size Category for Profiled Chemical Sectors (1996)

Employment Size Category	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)			Plastics Material and Resins (SIC 2821)			Organic Chemicals (SIC 2865, 2869)		
	No. of Firms	Number of Establish-ments	Estimated Receipts ($1999 millions)	No. of Firms	Number of Establish-ments	Estimated Receipts ($1999 millions)	No. of Firms	Number of Establish-meats	Estimated Receipts ($1999 millions)
0-19	296	296	380	195	195	457	219	220	642
20-99	124	140	1,238	77	77	1,341	139	149	2,638
100-499	63	109	2,589	37	56	3,011	65	94	4,845
500-2,499	51	199	3,457	35	93	5,318	61	119	9,499
2500+	91	652	20,318	59	209	28,123	112	286	56,572
Total	625	1,396	27,981	403	630	38,251	596	868	74,195

Source: Small Business Administration, Statistics of U.S. Businesses.

d. Concentration and Specialization Ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry and exit barriers with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[2] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of

[2] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios are therefore only one indicator of the extent of competition in an industry.

60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

Of the profiled Chemicals and Allied Products, only Alkalies and Chlorine (SIC 2812), Industrial Gases (SIC 2813), and Inorganic Pigments (SIC 2816) would be considered highly concentrated based on their CR4 and HHI values. These industries are characterized by heavy capital and technology requirements and large potential safety and environmental liabilities which present barriers to entry into the industry. In contrast, Industrial Inorganic Chemicals, NEC (SIC 2819), Plastics Material and Resins (SIC 2821), Cyclic Crudes and Intermediates (SIC 2865), and Industrial Organic Chemicals, NEC (SIC 2869) would be considered competitive but not concentrated.

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code. The specialization ratios presented in Table 4B-7 indicate a relatively high degree of specialization for each profiled chemical industry sector.

Table 4B-7: Selected Ratios for Four-Digit SIC Codes for Profiled Chemical Sectors

SIC Code	Year	Concentration Ratios					Specialization Ratio	Coverage Ratio
		4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
Inorganic Chemicals								
2812	87	72%	93%	99%	100%	2,328	86%	65%
	92	75%	90%	99%	100%	1,994	76%	75%
2813	87	77%	88%	95%	98%	1,538	98%	94%
	92	78%	91%	96%	99%	1,629	96%	94%
2816	87	64%	76%	94%	99%	1,550	94%	89%
	92	69%	79%	93%	99%	1,910	95%	89%
2819	87	38%	49%	68%	84%	468	91%	80%
	92	39%	50%	68%	85%	677	91%	82%
Plastics Material and Resins								
2821	87	20%	33%	61%	89%	248	88%	81%
	92	24%	39%	63%	90%	284	86%	80%
Organic Chemicals								
2865	87	34%	50%	77%	96%	542	80%	61%
	92	31%	45%	72%	94%	428	86%	61%
2869	87	31%	48%	68%	86%	376	75%	84%
	92	29%	43%	67%	86%	336	76%	85%

Source: Department of Commerce, Bureau of the Census, Census of Manufactures, 1992.

e. Foreign Trade

The chemicals industry is the largest exporter in the United States. The industry generates more than 10 percent of the nation's total exports. The industry's highest exports were $69.5 billion in 1997. Exports were lower in 1998 because the Asian economic crisis led to a reduction in sales to that region in 1998. U.S. imports of chemicals, mainly from Western Europe, rose an estimated 11 percent in 1999 (S&P, 2000).

This profile uses two measures of foreign competitiveness: ***export dependence*** and ***import penetration***. Export dependence is the share of value of shipments that is exported. Import penetration is the share of domestic consumption met by imports. Table 4B-8 presents trade statistics for each of the profiled chemical sectors. Both export dependence and import penetration have experienced modest positive trends in each of these sectors between 1989 and 1996. Globalization of the market has become a key factor influencing foreign competitiveness in the Inorganic Chemicals sector (SIC 281). In recent years import penetration has been increasing at a slightly higher rate than export dependence in this sector due to a strengthened U.S. dollar, weakness in the European and Japanese markets, and increased production in lower-cost developing nations (McGraw-Hill, 1998). Increased globalization has also been a dominant trend affecting trade statistics in the Plastics Material and Resins sector (SIC 2821). Imports and exports of plastics and resins have increased significantly over the past eight years reflecting the continued growth in the global market. Import penetration has grown more quickly than export dependence in this sector due to declining export opportunities and increased competition from imports driven by increased foreign capacity. The U.S. remains a net exporter of plastics and resins, despite these trends. The market for organic chemicals, particularly petrochemicals, has become increasingly competitive. Significant capacity expansions for petrochemicals worldwide have increased competition from imports and begun to limit export opportunities. Nevertheless, exports in Organic Chemicals (SIC 2865, 2869) have remained slightly higher than imports between 1989 and 1996.

Table 4B-8: Trade Statistics for Profiled Chemical Sectors						
Year	Value of imports ($1999 millions)	Value of exports ($1999 millions)	Value of Shipments ($1999 millions)	Implied Domestic Consumption†	Import Penetration††	Export Dependence†††
(a)	(b)	(c)	(d)	(e)	(f)	(g)
Inorganic Chemicals, Except Pigments (SIC 2812, 2813, 2819)						
1989	4,880	5,540	24,331	23,671	21%	23%
1990	4,955	5,342	26,913	26,526	19%	20%
1991	4,917	5,727	27,054	26,244	19%	21%
1992	4,921	6,060	28,412	27,273	18%	21%
1993	4,753	5,674	27,139	26,218	18%	21%
1994	5,170	5,728	23,809	23,251	22%	24%
1995	5,400	5,949	22,639	22,090	24%	26%
1996	5,707	5,819	22,161	22,049	26%	26%
Average Annual Growth Rate	*2%*	*1%*	*-1%*	*-1%*	*3%*	*2%*
Plastics Materials and Resins (SIC 2821)						
1989	1,506	5,351	32,241	28,396	5%	17%
1990	1,854	6,411	32,067	27,510	7%	20%
1991	1,838	7,645	30,616	24,809	7%	25%
1992	2,234	7,592	33,917	28,559	8%	22%
1993	2,718	7,751	34,049	29,016	9%	23%
1994	3,401	8,739	38,687	33,349	10%	23%
1995	3,668	9,284	39,094	33,478	11%	24%
1996	3,986	10,106	38,275	32,155	12%	26%
Average Annual Growth Rate	*15%*	*10%*	*2%*	*2%*	*13%*	*7%*
Organic Chemicals, Except Gum & Wood (SIC 2865, 2869)						
1989	6,727	11,455	82,187	77,459	9%	14%
1990	7,307	11,404	83,428	79,331	9%	14%
1991	7,585	11,664	79,863	75,784	10%	15%
1992	8,388	11,674	81,089	77,803	11%	14%
1993	8,530	12,159	82,534	78,905	11%	15%
1994	9,917	14,191	88,238	83,964	12%	16%
1995	10,244	15,142	76,611	71,713	14%	20%
1996	11,125	13,690	73,253	70,688	16%	19%
Average Annual Growth Rate	*7%*	*3%*	*-2%*	*-1%*	*9%*	*4%*

† Implied domestic consumption based on value of shipments, imports, and exports [column d + column b - column c].
†† Import penetration based on implied domestic consumption and imports [column b / column e].
††† Export dependence based on value of shipments and exports [column c / column d].

Source: Department of Commerce, International Trade Administration, Outlook Trends Tables.

4B.3 Financial Condition and Performance

The chemical industry is generally characterized by large plant sizes and technologically complex production processes reflecting the economies of scale required to manufacture chemicals efficiently. Because of the high fixed costs associated with chemical manufacturing operations, larger production volumes are required to spread these costs over a greater number of units in order to maintain profitability. ***Operating margins*** for chemical producers are generally volatile due to rapid changes in selling prices, raw material costs, energy costs, and production levels. Other factors that affect margins for chemical producers include costs associated with businesses recently acquired or divested, major new capacity additions, or environmental costs (S&P, 2000).

Facing increased global competition, the U.S. chemical industry has restructured and reduced costs to maintain profitability and operating margins. Cost-cutting efforts in the early 1990s came largely from restructuring and downsizing, particularly in the Inorganic Chemicals sector. The industry has recently shifted toward consolidation as a means of paring costs by achieving production or marketing efficiencies while maintaining growth in maturing markets (S&P, 2000). These transactions are typically small scale involving individual product lines or facilities and are most common in the Organic Chemical and Plastics and Resins Industry sectors.

Table 4B-9 presents operating margins for each of the profiled chemical sectors between 1987 and 1996.

Table 4B-9: Operating Margins for Profiled Chemical Sectors, (Millions of $1999)				
Year	**Value of Shipments**	**Cost of Materials**	**Payroll (all employees)**	**Operating Margin**
Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)				
1987	25,544	10,994	3,968	41.4%
1988	27,576	11,725	4,055	42.8%
1989	27,308	11,122	3,925	44.9%
1990	29,635	12,354	4,247	44.0%
1991	29,286	12,001	4,480	43.7%
1992	30,604	12,016	4,701	45.4%
1993	29,686	11,894	4,366	45.2%
1994	27,781	11,032	4,098	45.5%
1995	27,155	10,706	3,648	47.1%
1996	26,429	10,771	3,570	45.7%
Plastics Material and Resins (SIC 2821)				
1987	31,870	18,713	2,436	33.6%
1988	31,842	19,173	2,152	33.0%
1989	32,241	19,673	2,310	31.8%
1990	32,067	19,850	2,545	30.2%
1991	30,616	19,254	2,568	28.7%
1992	33,917	20,412	2,895	31.3%
1993	34,049	21,048	3,021	29.3%
1994	38,687	22,913	3,251	32.4%
1995	39,094	23,539	2,972	32.2%
1996	38,275	23,700	2,734	30.9%
Organic Chemicals (SIC 2865, 2869)				
1988	79,916	44,562	6,152	36.5%
1989	82,187	45,531	6,037	37.3%
1990	83,428	47,294	6,556	35.5%
1991	79,863	46,779	6,702	33.0%
1992	81,089	48,290	6,869	32.0%
1993	82,534	48,006	7,125	33.2%
1994	88,238	51,032	7,012	34.2%
1995	76,611	42,985	5,882	36.2%
1996	73,253	45,565	6,533	28.9%

Source: Department of Commerce, Bureau of the Census, Annual Survey of Manufactures.

4B.4 Facilities Operating CWISs

In 1982, the Chemical and Allied Products industry withdrew 2,797 billion gallons of cooling water, accounting for approximately 3.6 percent of total industrial cooling water intake in the United States. The industry ranked 2nd in industrial cooling water use behind the electric power generation industry (1982 Census of Manufactures).

This section presents information from EPA's *Industry Screener Questionnaire: Phase I Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from a water of the United States;
- they hold an NPDES permit;
- they have an intake flow of more than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the proposed §316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the proposed rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "§316(b) facilities."

a. Cooling Water Uses and Systems

Information collected in Screener Questionnaire found that an estimated 35 out of 435 inorganic chemical facilities (8 percent), 14 out of 305 plastics facilities (5 percent), and 58 out of 427 organic chemical facilities (14 percent) meet the characteristics of a §316(b) facility. Most §316(b) facilities in the profiled Chemical and Allied Products sectors use cooling water for contact and non-contact production line or process cooling, electricity generation, and air conditioning:

- All §316(b) *inorganic chemical* facilities use cooling water for production line (or process) contact or noncontact cooling. The two other major uses of cooling water are electricity generation and air conditioning, with approximately 31 and 27 percent of facilities, respectively.

- All §316(b) *plastics* facilities use cooling water for production line (or process) contact or noncontact cooling. Fifty, 22, and six percent also use cooling water for air conditioning, electricity generation, and other uses.

- Nintey-four percent of §316(b) *organic chemicals* facilities use cooling water for production line (or process) contact or noncontact cooling. Forty-five, 41, and 17 percent of facilities use cooling water for air conditioning, other uses, and electricity generation, respectively.

Table 4B-10 shows the distribution of existing §316(b) facilities in the profiled chemical sectors by type of water body and cooling system. The table shows that most of the existing §316(b) facilities have either a once through system (56, or 52 percent) or employ a combination of a once through and closed system (30, or 28 percent). The majority of existing facilities draw water from a freshwater water stream or river (82, or 77 percent).

Table 4B-10: Number of §316(b) Facilities by Water Body and Cooling System Type for Profiled Chemical Sectors

Water Body Type	Cooling System						
	Closed Cycle		Once Through		Combination		Total
	Number	% of Total	Number	% of Total	Number	% of Total	
Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)							
Estuary or Tidal River†	0	0%	3	39%	5	61%	9
Freshwater Stream or River	2	13%	9	56%	5	31%	17
Ocean	0	0%	9	100%	0	0%	9
Total††††	***2***	***6%***	***22***	***63%***	***10***	***30%***	***35***
Plastics Material and Resins (SIC 2821)							
Estuary or Tidal River††	0	0%	0	0%	1	100%	1
Freshwater Stream or River	0	0%	4	33%	8	67%	12
Lake or Reservoir	0	0%	1	100%	0	0%	1
Total††††	***0***	***0%***	***5***	***36%***	***9***	***64%***	***14***
Organic Chemicals (SIC 2865, 2869)							
Estuary or Tidal River	0	0%	4	100%	0	0%	4
Freshwater Stream or River†††	18	34%	24	45%	11	21%	53
Ocean	0	0%	1	100%	0	0%	1
Total††††	***18***	***31%***	***29***	***50%***	***11***	***19%***	***58***
Total for Profiled Chemical Facilities (SIC 28)							
Estuary or Tidal River†	0	0%	7	50%	6	43%	14
Freshwater Stream or River	20	24%	37	45%	24	29%	82
Ocean	0	0%	10	100%	0	0%	10
Lake or Reservoir	0	0%	1	100%	0	0%	1
Total††††	**20**	**19%**	**56**	**52%**	**30**	**28%**	**107**

† One of the inorganic chemical facilities on an estuary or tidal river also has a CWIS on a lake or reservoir.
†† One plastics facility on an estuary or tidal river also has a CWIS on a lake or reservoir.
††† One of the organic chemicals facilities on a freshwater stream or river also has a CWIS on a lake or reservoir.
†††† Individual numbers may not add up to total due to independent rounding.

Source: EPA, Industry Screener Questionnaire: Phase I Cooling Water Intake Structures, 1999.

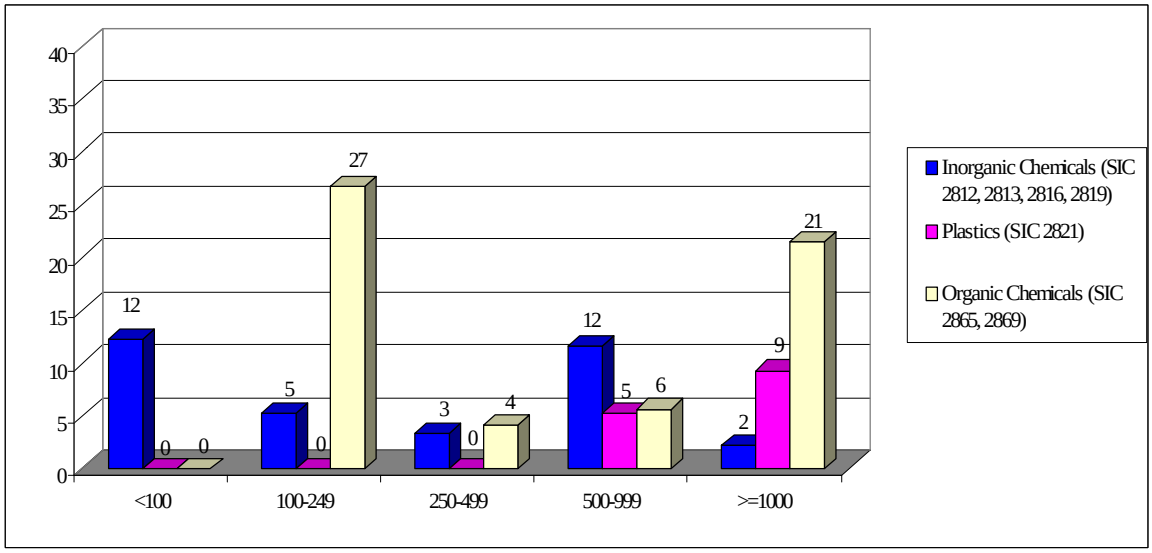
b. Facility Size

Chemical facilities that withdraw more than two MGD from a water of the U.S., hold an NPDES permit, and use at least 25 percent of intake water for cooling purposes are generally larger than facilities that do not meet these criteria:

- Ninety percent of all facilities in the Inorganic Chemicals sector have fewer than 100 employees but only 34 percent of §316(b) facilities in that sector fall into that employment category.
- Seventy-one percent of all facilities in the Plastics and Resins and the Organic Chemicals sectors have fewer than 100 employees compared to none of the §316(b) facilities in those sectors.
- The majority of §316(b) plastics facilities (64 percent) employ over 1,000 employees.
- §316(b) industrial organic facilities are more evenly distributed across employment categories with 23 facilities (43 percent) employing 100 to 249 employees and 21 facilities (39 percent) employing over 1,000 employees.

Figure 4B-7 shows the number of §316(b) facilities in the profiled chemical sectors by employment size category.

Figure 4B-7: Number of §316(b) Facilities by Employment Size Category for Profiled Chemical Sectors



Source: EPA, Industry Screener Questionnaire: Phase I Cooling Water Intake Structures, 1999.

c. Firm Size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing §316(b) facilities in the three profiled chemical sectors that are owned by small firms. Firms in the Inorganic Chemicals sector (SIC codes 2812, 2813, 2816, 2819) and in Industrial Organic Chemicals, NEC (SIC code 2869) are defined as small if they have 1,000 or fewer employees; firms in Plastics Material and Resins (SIC 2821) and Cyclic Organic Crudes and Intermediates (SIC code 2865) are defined as small if they have 750 or fewer employees.

Table 4B-11 shows that of the 35 §316(b) facilities in the Inorganic Chemicals sector, five, or 14 percent, are owned by a small firm. None of the 19 §316(b) facilities in the Plastics sector are owned by a small firm. In the Organic Chemicals sector, four of the 58 §316(b) facilities, or seven percent, are owned by a small firm. Another two facilities, or two percent, are owned by a firm of unknown size which may also qualify as a small firm.

Table 4B-11: Number of §316(b) Facilities by Firm Size for Profiled Chemical Sectors

SIC Code	Large		Small		Unknown		Total
	No.	% of SIC	No.	% of SIC	No.	% of SIC	
Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)							
2812	10	100%	0	0%	0	0%	10
2813	4	100%	0	0%	0	0%	4
2816	0	0%	4	100%	0	0%	4
2819	16	94%	1	6%	0	0%	17
Total	***30***	***86%***	***5***	***14%***	***0***	***0%***	***35***
Plastics Material and Resins (SIC 2821)							
2821	14	100%	0	0%	0	0%	14
Organic Chemicals (SIC 2865, 2869)							
2865	5	100%	0	0%	0	0%	5
2869	46	88%	4	8%	2	4%	53
Total	***51***	***89%***	***4***	***7%***	***2***	***4%***	***58***
Total for Profiled Chemical Facilities (SIC 28)							
Total	**95**	**89%**	**9**	**9%**	**2**	**2%**	**107**

Source: EPA, Industry Screener Questionnaire: Phase I Cooling Water Intake Structures, 1999; D&B Database, 1999.

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